Energy Optimization in Smart Networks using Nature-Inspired Techniques

SHORT SYNOPSIS

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by

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DECLARATION BY THE SCHOLAR

I hereby declare that the short synopsis entitled "Energy Optimization in Smart Networks using Nature-Inspired Techniques" being submitted in partial fulfillment of the requirement for the degree of Doctor of Philosophy in the Department of Computer Science and Technology under the School of Engineering of Manav Rachna University, Faridabad during the academic year 2022-23.

It is the work that is expected to be carried out under the supervision of Dr. Sachin Lakra.

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CERTIFICATE BY SUPERVISOR

This is to certify that, the short synopsis entitled "Energy Optimization in Smart Networks using Nature-Inspired Techniques" is an original piece of work done by the research scholar Mr. Agha Imran Husain, under the supervision of Dr. Sachin Lakra for the degree of Doctor of Philosophy in the Department of Computer Science & Technology under the School of Engineering of Manav Rachna University, Faridabad during the academic year 2022-2023.

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ABSTRACT

One of the biggest issues affecting our Earth right now is climate change. The increase in global temperatures, which has significant effects on the environment and human existence, is one of the main markers of climate change. In recent years, wireless sensor networks (Heinzelman et al., 2002) (WSNs), a type of communication technology, have gained popularity, in the field of environmental monitoring, in particular. WSNs must need a lot of energy to run, though, which increases greenhouse gas emissions and hastens impact of the climate change. As a result, there are increasing needs to create WSNs that are energy-efficient and have less effect on the environment. This includes creating new protocols and technologies that can lower energy use, as well as utilizing renewable energy sources to power WSNs. We can continue to take advantage of the numerous benefits that WSNs provide in environmental monitoring and other domains while addressing the energy consumption of WSNs. Swarm intelligence is a concept that draws inspiration from how social creatures like ants, bees, and birds behave. It makes use of decentralized systems of agents that communicate with one another to accomplish a shared objective. By making the best use of available resources and cutting down on pointless communication, this strategy has been used in Wireless Sensor Networks (WSNs) to reduce energy usage. Swarm intelligence can be used to modify WSNs in such a manner that nodes cooperate to create effective communication channels and save energy by shutting off extraneous sensors or lowering the transmission frequency. Swarm intelligence can also increase the robustness and dependability of WSNs by enabling nodes to react to network changes and modify their behavior accordingly. With this strategy, WSNs might consume substantially less energy and become more environmental-friendly while still being useful for environmental monitoring and other applications.

Keywords: Climate Change, Wireless Sensor Networks, Swarm Intelligence, Transmission, Communication.

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1. Introduction

1.1 Green Computing

The activity of creating, developing, and utilizing computer systems and technology in an environmentally responsible way is referred to as green computing, sometimes known as green IT. Green computing aims to lessen the negative effects of computing technology on the environment, particularly its energy use and carbon emissions. This can be done in a number of ways, including by using energy-efficient hardware, virtualization, cloud computing, and adopting sustainable habits like recycling and waste minimization. Organizations can adopt green computing methods to lower their carbon footprint, save money on energy, and boost overall operational effectiveness.

In order to lessen the environmental effects of our growing reliance on technology and on the digital world, green computing is more crucial than ever. Green computing encompasses not only the developed and used software and applications, but also the hardware and infrastructure of computing systems. The energy consumption of computing systems can be greatly decreased through the creation of energy-efficient software. Using cloud computing can also lessen the need for physical infrastructure, such as servers and data centers, which lowers energy use and carbon emissions. Because it helps to lessen the unfavorable effects of technology on the environment, green computing is a crucial component of sustainable development in the technology sector. Green computing techniques must be included in business and organization operations if they want to lessen their impact on the environment, save money on energy, and encourage sustainable development. Green computing is a crucial field that calls for ongoing efforts from people and organizations to lessen the negative effects of technology on the environment while moving towards a sustainable future.

Green computing is a concept that focuses on creating ecologically sustainable computer systems and technologies. Enhancing wireless sensor network energy efficiency is one of the key components of green computing (WSNs). Small, low-power devices that are deployed as part of WSNs are used to gather environmental data. Because WSN devices often rely on batteries, which have a finite lifespan, energy efficiency is crucial. Many methods, such as optimizing routing protocols, lowering data transmission rates, and employing sleep modes, can be utilized

to increase energy efficiency. WSNs can run more effectively, use less energy, and ultimately become more environmentally friendly by putting these techniques into practice.

1.2 Motivation

Effective solutions for energy conservation can be found in the biological subject of cellular automation and genetics systems and swarm-honey bees. There are a lot more interesting examples of how a nature-inspired analogy can be leveraged to resolve challenging application issues in sensor networks. The algorithms were based on natural science, and they solved the issues using the self-behavior system of nature. These actions are carried out by organisms with little access to resources or processing power. Natural science is a good example of how the value of an interdisciplinary approach may be leveraged to create a new environment for networking engineering difficulties (Wagh & Prasad, 2013).

Nature Inspired Techniques have been used in a number of existing strategies for energy efficiency in wireless sensor networks (WSNs), including:

A. Clustering: By lowering communication overhead, clustering the nodes can save energy usage. Nodes are grouped together into clusters using clustering techniques like k-means and fuzzy c-means, with a chosen cluster head for each cluster.

B. Routing: Swarm intelligence techniques can be used to improve routing in WSNs, including ant colony optimization (Dorigo & Stützle, 2004), particle swarm optimization (Kennedy & Eberhart, n.d.), and the bees algorithm. By identifying the data transmission routes that require the least energy, these algorithms can reduce energy use.

C. Scheduling: By decreasing collisions and improving energy efficiency, scheduling data transmission in WSNs helps lower energy usage. Artificial bee colonies (ABC) and other swarm intelligence algorithms can be used to schedule the transmission of data.

D. Power management: Artificial bee colonies (ABC) and other swarm intelligence techniques can be utilized to improve power management in WSNs. To save energy, nodes can be programmed to turn off their radio or lower the broadcast power at predetermined intervals.

E. Self-organization: By allowing the nodes to self-organize to maximize energy efficiency, energy consumption can be decreased. To save energy, nodes can dynamically change their routing patterns or their transmission power.

F. Sleep schedule: To save energy, the nodes can be programmed to go into a low-power sleep mode at certain periods using swarm intelligence algorithms like artificial bee colonies (ABC).

It is crucial to remember that the energy efficiency of WSNs depends on unique network circumstances, such as network size, mobility, and traffic. Therefore, it is important to evaluate the energy efficiency of these techniques under different conditions to choose the best one for a given scenario.

1.3 Problems due to Energy Consumption

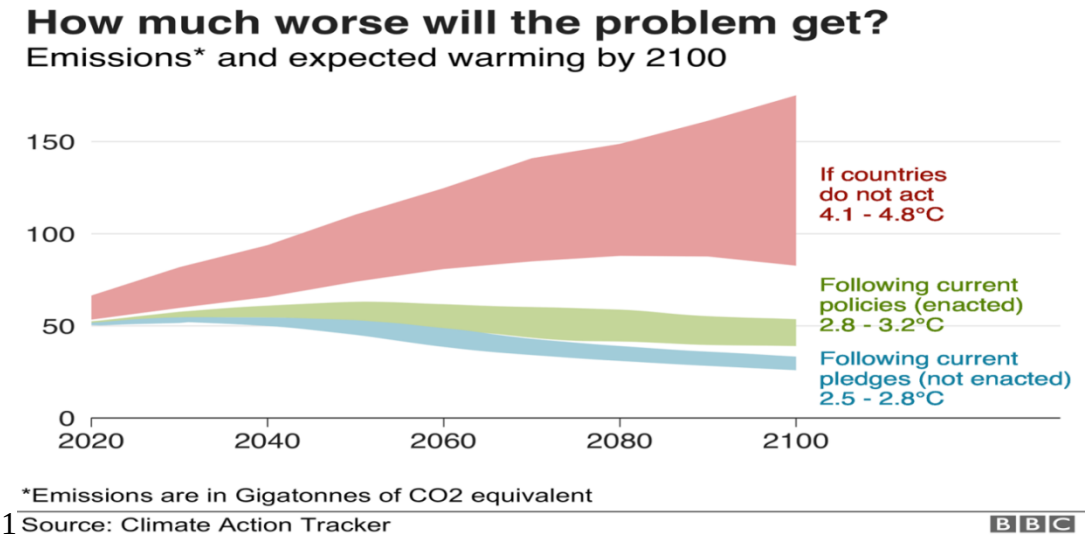
We currently face significant environmental challenges related to global warming and climate change. The rising energy consumption of wireless sensor networks (WSN) (Kochhar & Kumar, 2019) networks is one of the main causes of these problems. As the need for WSNs grows, so does the amount of energy needed to power them, which raises greenhouse gas emissions and ultimately contributes to global warming and climate change.

The Paris Convention, also known as the United Nations Framework Convention on Climate Change (UNFCCC), was held in Paris, France, in December 2015. While also working to limit it to 1.5 degrees Celsius, we must keep global warming far below 2 degrees Celsius above pre-industrial levels, it is urgently necessary to address climate change and cut greenhouse gas emissions. The Paris Agreement acknowledged the mounting scientific evidence of human-caused climate change and the detrimental effects it is already having on the planet, including rising sea levels, harsh weather, and ecological damage. The treaty demanded immediate action to lower greenhouse gas emissions through a combination of financing, adaptation initiatives, and mitigation measures.

Even with all of the pledges made by signatory nations to the Paris Climate Agreement to reduce emissions, the earth will still warm by more than 3 Celsius by the end of this century.

Figure 1

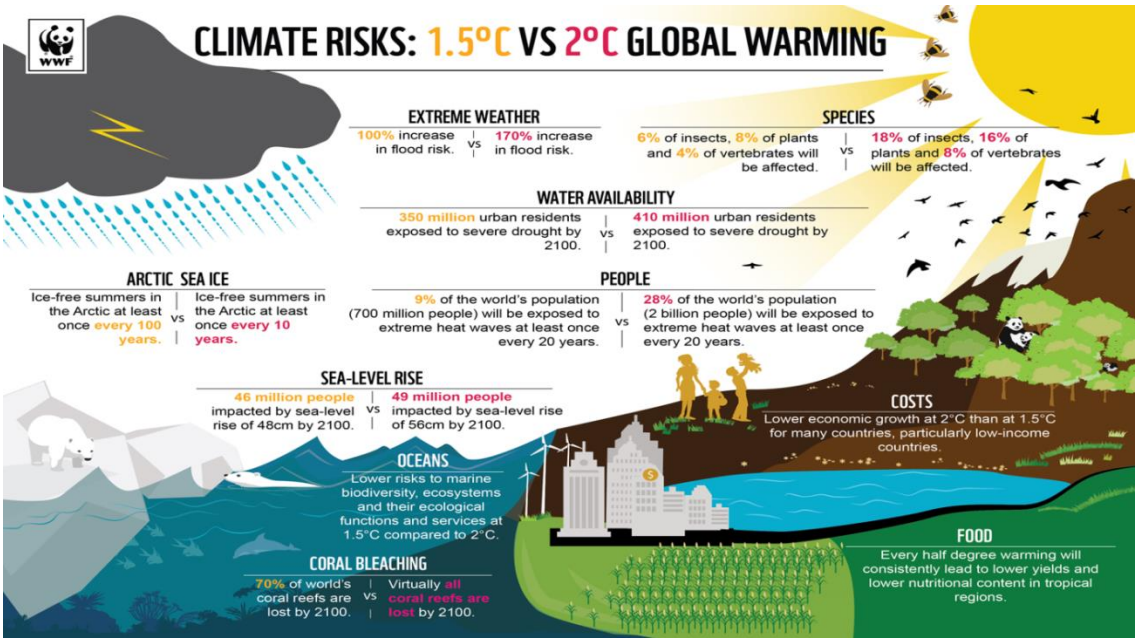
Carbon Emission Impact on Global Temperature



Note: How much worse will the problem get? Emission and expected warning by 2100. (2020, January 14). bbc.com. https://www.bbc.com/news/science-environment-46384067

Figure 2

Climate Risks


CLIMATE RISKS: 1.5°C VS 2°C GLOBAL WARMING
WWF
EXTREME WEATHER
100% increase in flood risk. vs 170% increase in flood risk.
SPECIES
6% of insects, 8% of plants and 4% of vertebrates will be affected. vs 18% of insects, 16% of plants and 8% of vertebrates will be affected.
WATER AVAILABILITY
350 million urban residents exposed to severe drought by 2100. vs 410 million urban residents exposed to severe drought by 2100.
ARCTIC SEA ICE
Ice-free summers in the Arctic at least once every 100 years. vs Ice-free summers in the Arctic at least once every 10 years.
PEOPLE
9% of the world's population (700 million people) will be exposed to extreme heat waves at least once every 20 years. vs 28% of the world's population (2 billion people) will be exposed to extreme heat waves at least once every 20 years.
SEA-LEVEL RISE
46 million people impacted by sea-level rise of 48cm by 2100. vs 49 million people impacted by sea-level rise of 56cm by 2100.
COSTS
Lower economic growth at 2°C than at 1.5°C for many countries, particularly low-income countries.
OCEANS
Lower risks to marine biodiversity, ecosystems and their ecological functions and services at 1.5°C compared to 2°C.
CORAL BLEACHING
70% of world's coral reefs are lost by 2100. vs Virtually all coral reefs are lost by 2100.
FOOD
Every half degree warming will consistently lead to lower yields and lower nutritional content in tropical regions.

Note: The Urgency of 1.5 °C. (2020). wwf.panda.org. https://wwf.panda.org/discover/our_focus/climate_and_energy_practice/ipcc152/

In a wireless sensor networks (Heinzelman et al., 2002), each sensor node typically perceives its surrounding environment and relays pertinent data to a base station upon request (BS). To increase the security and dependability of this task in a wireless sensor network that may be hostile and unstable, a hybrid multipath technique (H-SPREAD) is offered (Lou et. al., 2006). Considering all of these optimization issues holistically is difficult due to the fact that they span several layers of the network protocol stack. It is important to research network optimization methods in wireless sensor networks (Ren et al., 2006).

The majority of current research projects primarily focus on one or more of them in terms of specific applications or goals. For wireless sensor networks (Lee et al., 2006) offer an innovative routing technique they call information-aware collaborative routing. (Ali et al., 2011) provide a critique of PSO and ACO-based algorithms together with other techniques used to optimize wireless sensor network routing protocols. The design of a multi-interface wi-fi node for a sensor network was studied by Chen et al. in 2011.

A multi-interface Wireless Sensor Network (WSN) node with several interfaces has been built. In hierarchically clustered wireless sensor networks, (Alla et al., 2012) provide the Coverage and Connectivity Preservation Routing Protocol to support connection, energy balancing, and coverage preservation for sensor nodes (CCPRP). (Tze et al., 2012) examine how adaptive particle swarm optimization can cluster wireless sensor nodes. It is suggested to integrate the CHs distribution with adaptive particle swarm optimization (APSO). A novel hybrid ABCACO algorithm is presented by Kumar et al. (2016) to address the nondeterministic polynomial (NP) hard and finite problem of WSNs. To extend the overall network lifetime, (Jangwan et al., 2017) introduce a cluster-head (CH) selection method based on swarm optimization.

A cluster-based dynamic energy management system is proposed by Wang et al. (2007) to address the energy issue of target tracking in wireless sensor networks. In wireless sensor networks, both the overall energy and the energy of each node are finite. An effective energy cluster-based routing strategy for wireless sensor networks is studied by (Xi-rong et al., 2009). A wireless sensor network Efficient Energy Cluster-based Routing Protocol (EECRP) is introduced, and its characteristics are examined.

An important goal is to figure out how to maximize clustering, decrease node energy consumption, and balance network energy dissipation in light of the energy limitations characteristics of Wireless Sensor Networks (Ma et. al., 2013) Niching Particle Swarm Optimization (NPSO)-based Energy Efficient Clustering protocol is proposed; the algorithm takes into account the state of neighboring nodes as well as the long-lasting energy of the nodes. Theoretical study and simulation outcomes demonstrate that the newly proposed routing protocol can more effectively balance energy consumption, enhance the networks' energy efficiency, and extend the lifetime of the networks (Jian-qi et. al., 2013).

Wang et al. (2013) describe a Particle Swarm Optimization-based trust QoS routing technique for WSNs (PSO). In a cluster-based wireless sensor network, the hot spot problem caused by multi-hop communication is addressed by (Azharuddin et al., 2016) by proposing a PSO-based solution. The points on the cluster and the choice of the cluster head using the chicken group optimization technique were polished and improved on the basis of LEACH agreement. The population variety was improved, the algorithm's ability to conduct a worldwide search was ensured, and Levy flight was updated to establish the position of chickens that fall within the local optimum (Wang et. al., 2017). To cut back on energy use and increase network lifetime, (Sangeetha et al., 2018)

2. Literature Review

The development of energy-efficient (EE) strategies for the motif of design of wireless communication systems is required due to the anticipated increase in wireless communication traffic. Based on these techniques we have reviewed the work of several authors related to Energy Efficiency using Nature Inspired Techniques.

2020 (Ogbebor et al.) This research investigates the construction of an energy-efficient wireless communication network. It shows a complete taxonomy that lists the places where each strategy has an impact on the network. The popularity of prediction-based energy-efficient technology is highlighted, along with some of its drawbacks, before improvements in renewable energy supply systems for future networks are covered. It advocates for improved cross-vendor collaboration and context-specific energy-efficient research initiatives to push the limits of energy efficiency in wireless communication network architecture. According to the study's findings, there are three

different types of energy-efficiency techniques: effective node design and operation, effective node-to-node communication, and effective node data management. Additionally, it reveals that although prediction-based energy-efficient strategies are gaining popularity, their potential is constrained by their computational complexity. The article also concludes that cross-vendor partnerships and context-specific energy-efficient research activities are required to advance the design of wireless communication networks' energy efficiency. Renewable energy supply systems are also becoming increasingly significant for future networks.

(Kumar et al., 2020) suggested that the ACO algorithm suitable for each network be employed. (Kumar et al., 2020) presented the argument that K-means-based clustering performs the best in an IoT scenario when comparing various clustering approaches to analyze scheduler performance. The authors propose that in a variety of network nodes and with regard to flexible network architecture issues, the ACO chooses the route for broadcast signals. It was found during simulated research that the Internet of Things ACO effectively reduces the transmission storm by deciding the path.

(Tahiliani & Dizalwar, 2018) raises the issue of energy consumption in IoT-based devices and is being prioritized for study, due to the increased number of high-performance and complex devices connected to the IoT system, that require a significant amount of energy. IoT systems may operate in a sustainable environment if IoT devices use less energy. This paper presents the most recent, state-of-the-art research on energy optimization in IoT. The authors reviewed the literature, categorized the currently employed energy-efficient techniques, and presented untapped problems and potential to the research community. The main contribution of this work is a systematic tabular review and analysis of available energy-aware approaches based on different IoT levels and components.

(Jo & Yoon, 2018) proposed Services for intelligent IoT energy efficiency in smart homes. As a result, a variety of network and energy-efficiency services for smart homes are being researched. Studies related to the smart grid are still ongoing for a number of reasons. These methods enable intelligent learning to be applied to IoT data in order to provide IoT devices with awareness of their immediate surroundings. IoT is only engaged when it is required under the given circumstances.

(Heinzelman et al., 2002) The Authors proposed, novel protocol architecture for wireless sensor networks is suggested (WSNs). The authors point out the need for protocol designs tailored specifically for each type of WSN application in order to address their individual needs. They present the application, middleware, and network layers of the application-specific protocol architecture (ASPA). The ASPA offers a flexible and modular framework for creating specialised protocols for different WSN applications. A series of recommendations for designing protocols that are optimised for low power consumption, scalability, and reliability is also put forth by the authors. To show the value of the ASPA technique, the paper finishes with a case study of a traffic monitoring application. Overall, the article offers a thorough foundation for creating wireless sensor network protocol designs that are both effective and application-specific.

(Morley et al., 2018) This research argues that a deeper understanding of how everyday practices are evolving in conjunction with the availability and design of online services could serve as the foundation for the policies and actions necessary to minimize the most worrisome Internet energy consumption estimates. The article also discusses possible contributions from information and communication infrastructures to peak electricity demand, as well as research goals and approaches for examining data consumption.

(Sodhro et al., 2018) proposed wireless body sensor networks (WBSNs), an adaptive power control method is recommended to improve energy efficiency. These Transmission Power(TP) levels, which are determined using the received signal strength indicator (RSSI) value as shown in, are used by the Transmission Power Control (TPC) algorithm to compare rate control strategies with each other in terms of energy efficiency. In this study, the energy efficiency of the rate control method and the TPC algorithm are compared using a general model of WBSN energy consumption.

(Al-Turjman et al., 2019)This special issue's (SI) objective was to concentrate based on theoretical with practical elements With IoT-enabling technologies, green next-generation networks or networks can be leveraged to deliver green solutions.

(Zhang et al., 2017) suggested a protocol that may virtualize a multi-hop data transmission into several one-hop dependable communications, effectively resolving the performance deterioration

issue with multi-hop Transmission Control Protocol(TCP) transmissions in a wireless IoT setting. In multi-hop wireless communication, the chance of end-to-end packet loss rises linearly with packet hopping, leading to a small congestion window size at the TCP sender and a significant end-to-end delay. It is not essential for the source node and the destination node to communicate data in real time at the same time.

Wang et al. (2020) proposed Hierarchical cluster-based routing protocols, which have been identified as the most effective network organization technique. This technique was proposed to improve the energy efficiency of WSNs. These block clustering-based techniques can lessen uneven energy use by selecting CHs (Cluster Heads) based on residual energy and other more relevant factors.

(Heo et al., 2006) To find the optimum answer to the multiobjective optimization issue, where the objective functions are provided with preferences, introduce a contemporary heuristic technique, particle swarm optimization. In power system operation research, the differential evolutionary technique for optimal dispatch for reactive power and voltage management is described (Varadarajan et al., 2008). An innovative technique for distributed generator daily Volt/Var control in distribution networks is provided by (Niknam, 2008). (DGs). An efficient and dependable evolutionary-based approach can be used to resolve the optimal power flow (OPF) problem, according to (Ela et al., 2009).

Analysis of wireless sensor network power management and system delay by Oswald et al. (2004). A technique for figuring out the ideal amount of sleep is created and provided, together with reference data that covers a wide range of orders of magnitude. An approach based on elastic neural networks is created for the task allocation of cooperative techniques in wireless sensor networks in order to decrease energy consumption in the setting of multi-sensor tracking (Haihao et. al., 2007). In wireless sensor networks, multiagent-based cooperative signal processing is studied by Yan et al. (2008). It is suggested to use cooperative signal processing multi-agent for target tracking in wireless sensor networks.

The total energy and the energy of each node in WSNs are both finite. We investigate an efficient energy cluster-based routing approach for wireless sensor networks (Xi-rong et al.,

2009). We introduce and analyze the properties of a wireless sensor network Efficient Energy Cluster-based Routing Protocol (EECRP). (Latiff et al., 2011) propose a technique called particle swarm optimization (PSO) as an energy-efficient protocol for the mobility of mobile base stations in wireless sensor networks.

The repositioning of mobile base stations in wireless sensor networks is proposed by (Latiff et al., 2011) using the protocol known as particle swarm optimization (PSO). (Tze et al., 2012) investigate the clustering of wireless sensor nodes using adaptive particle swarm optimization. It is advised to combine adaptive particle swarm optimization with the CHs distribution (APSO). Using Niching Particle Swarm Optimization (ENPC-NPSO), a protocol that effectively divides the network field and considers network state information while choosing cluster heads is studied by (Ma et al., 2013). (CHs).

For wireless sensor networks, Tillapart et al. (2005) propose a hybrid clustering and routing design. concentrating on the target tracking energy issue in wireless sensor networks A cluster-based dynamic energy management system is suggested by (Wang et al., 2007). (Singh et al., 2012) investigate the analysis of packet retransmissions in WSNs and energy-aware cluster head selection using particle swarm optimization. The Particle Swarm Optimization (PSO) method is used to create energy-aware clusters with the best cluster head choice. For cluster-based WSNs, (Amgoth et al., 2015) offer an energy-aware routing algorithm. (Ho et al., 2015) discuss the usage of Unmanned Aerial Vehicles (UAVs) for data collection and the choice of sensor network communication topology.

3. Description of Broad Area

The energy consumption of WSN networks is a big issue since it has a variety of negative effects on the environment. Carbon emissions rise as a result of excessive energy use, which supports the greenhouse effect and the rise in global temperatures. Natural disasters like hurricanes, floods, and wildfires become more frequent as a result, harming both the environment and people’s lives.

To overcome this problem, the design and operation of WSN networks must incorporate energy-efficient practices. This can be accomplished by using sustainable energy sources like solar or

wind energy, and by creating hardware and software that are energy-efficient for WSN devices. By following these steps, we may lessen the environmental effects of energy use and move towards a more sustainable future.

The focus of the study is on energy-efficient approaches that are inspired by nature, such as cluster head selection based on flying ducks and ant load transportation for data sensing and transmission. Traditional energy optimization strategies have a large computational power consumption and may affect accuracy if constrained, which raises worries about energy efficiency in this field of research.

The creation of novel, energy-efficient, and naturally inspired models that successfully complete their duties using wholly new methodologies may be the area of study attention. The objective of this research is to develop accurate and energy-efficient models that are inspired by nature in order to overcome the limits of conventional optimization techniques.

There are many ways we can investigate several forms of nature-inspired models, like PSO, ACO, and genetic algorithms, to achieve the focus of this research. To increase the models' energy efficiency, they might also look into ways to incorporate load movement by ants and flying ducks based on head selection.

The usefulness and efficiency of the developed models may also need to be tested by us through the design and execution of experiments or simulations. The outcomes of these tests or simulations would offer perceptions of how well the models performed and could guide further development.

Overall, the project aims to address the energy efficiency-related difficulties in the main area of nature-inspired energy-efficient procedures by building revolutionary low-energy nature-inspired models that accurately carry out their tasks, with completely novel methodologies.

4. Objectives of the Research Work

- To calculate and predict the response time for message forwarding of the allocated network premises.
- To find the suitable cluster head, reduce the energy consumption/cost in the given

network area.

- To develop and simulate a smarter energy-efficient approach for the transmission of data, which could reduce carbon emissions from devices.
- To improve the existing method for better clustering of sensor networks, that enhances the performance of the transmission.
- To compare existing techniques with the proposed techniques.

5. Methodology to be adopted

Nature-inspired energy-efficient techniques including

1. **Sensing and transmission of data packets based on load transportation by Swarm Intelligence (SI).**

SI is a computational technique that draws its inspiration from the group behavior of social creatures like ducks and honey bees. In the field of data communication, SI has been proposed as a means of optimizing the sensing and transmission of data packets based on load transportation.

In a network that uses SI, each node, or agent, is assigned a set of tasks to perform. These tasks are coordinated through a decentralized process, where each node bases its judgments on information found locally and the coordinated actions of nearby nodes. This allows the network to respond dynamically to changing conditions, such as changes in the load on different nodes or changes in the quality of the communication channel.

One of the key features of SI is the ability to balance the load among the nodes in the network. This can be accomplished through algorithms that distribute the tasks evenly among the nodes, or by adjusting the allocation of resources based on the load on each node. In this way, SI can help ensure that data packets are transmitted efficiently, even when there is a large amount of traffic in the network.

The use of Swarm Intelligence in data communication networks can help optimize the sensing and transmission of data packets by dynamically balancing the load on different nodes. This can lead to improved performance, increased reliability, and reduced energy consumption in the network.

2. Swarm Intelligence-based cluster head selection.

SI can be used to pick cluster heads in WSNs to improve the efficiency and effectiveness of data transmission. In WSNs, a cluster head is a node that is responsible for collecting data from other nodes and forwarding it to a central sink. The selection of cluster heads is a critical aspect of WSN design, as it affects the network's energy consumption, communication overhead, and overall performance.

SI-based cluster head selection algorithms aim to find the optimal set of cluster heads that satisfies certain criteria, such as energy consumption, network coverage, and load balancing. For example, a simple SI-based algorithm could be based on the Ant Colony Optimization (ACO) method, where each node acts as an ant and explores the network, selecting the best cluster head based on a heuristic function. The heuristic function can take into account various factors, such as the node's remaining energy, the number of nodes in its vicinity, and the distance to the sink.

Another SI-based approach to cluster head selection is Particle Swarm Optimization (PSO). In PSO, each node is represented by a particle, and the optimization process involves adjusting the position of the particles in the network to find the best cluster heads. The position of each particle is updated depending on the particle's current location, the highest position it has ever reached, and the highest positions attained by other particles in the area.

In conclusion, SI-based cluster head selection is a promising approach for optimizing data transmission in WSNs. By dynamically balancing the load and energy consumption among the nodes, SI-based algorithms can lead to improved performance, increased reliability, and longer network lifetime.

6. Proposed/expected outcome of the research

The expected outcomes of the proposed work will be achieved effectively and the outcome will be acceptable to the research community. The expected outcomes will be as follows:

- In order to reduce energy consumption during the sensing and transmission of data packets while preserving precise data measurement and coverage requirements in Smart Networks, nature-inspired energy reduction strategies can be implemented, such as load carrying by ants. In addition to reducing the amount of transmission energy used, this enhances the security and accuracy of Smart Networks.
- A smart network can choose the best cluster head by using a classifier inspired by nature, which will significantly reduce power consumption and identify the best node for the cluster head's functionality.
- An effective method that will computationally reduce carbon emission in terms of run-time, will be developed.

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Abstract

One of the biggest issues affecting our Earth right now is climate change. The increase in global temperatures, which has significant effects on the environment and human existence, is one of the main markers of climate change. In recent years, wireless sensor networks (Heinzelman et al., 2002) (WSNs), a type of communication technology, have gained popularity, in the field of environmental monitoring, in particular. WSNs must need a lot of energy to run, though, which increases greenhouse gas emissions and hastens impact of the climate change. As a result, there are increasing needs to create WSNs that are energy-efficient and have less effect on the environment. This includes creating new protocols and technologies that can lower energy use,

as well as utilizing renewable energy sources to power WSNs. We can continue to take advantage of the numerous benefits that WSNs provide in environmental monitoring and other domains while addressing the energy consumption of WSNs. Swarm intelligence is a concept that draws inspiration from how social creatures like ants, bees, and birds behave. It makes use of decentralized systems of agents that communicate with one another to accomplish a shared objective. By making the best use of available resources and cutting down on pointless communication, this strategy has been used in Wireless Sensor Networks (WSNs) to reduce energy usage. Swarm intelligence can be used to modify WSNs in such a manner that nodes cooperate to create effective communication channels and save energy by shutting off extraneous sensors or lowering the transmission frequency. Swarm intelligence can also increase the robustness and dependability of WSNs by enabling nodes to react to network changes and modify their behavior accordingly. With this strategy, WSNs might consume substantially less energy and become more environmental-friendly while still being useful for environmental monitoring and other applications.

Keywords: Climate Change, Wireless Sensor Networks, Swarm Intelligence, Transmission, Communication

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